LCD Module User Manual

Customer	:	
MASS PRODUCTION CODE	:	TG160128B-03WA0
DRAWING NO.	:	M-TG160128B-03WA0_A00

Approved By Customer:

Date:

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1. Precautions in Use of LCD Module

(1) Avoid applying excessive shocks to the module or making any alterations or modifications to it.
(2) Don't make extra holes on the printed circuit board, modify its shape or change the components of LCD Module.
(3) Don't disassemble the LCM.
(4) Don't operate it above the absolute maximum rating.
(5) Don't drop, bend or twist LCM.
(6) Soldering: only to the I/O terminals.
(7) Storage: please storage in anti-static electricity container and clean environment.

2. General Specification

ITEM	STANDARD VALUE	UNIT
Number of dots	160X128	Dots
Outline dimension	129.0(W)X104.5(H)X12.0MAX.	mm
View area	101.0(W)X82.0(H)	mm
Active area	95.96(W)X76.76(H)	mm
Dot size	0.56(W)X0.56(H)	mm
Dot pitch	0.60(W)X0.60(H)	mm
LCD type	STN,Grey,positive, transflective	
View direction	6 o'clock	
Backlight	White LED	

3. Absolute Maximum Ratings

ITEM	SYMBOL	MIN.	TYPE	MAX.	UNIT
Operating Temperature	T_{OP}	0	-	+60	℃
Storage Temperature	T_{ST}	-10	-	+70	℃
Input Voltage	V_I	-0.3	-	V_{DD} +0.3	V
Supply Voltage For Logic	V_{DD}	0	-	5.5	V
Supply Voltage For LCD	V_{DD}-V_{EE}	0	-	20.0	V

4. Electrical Characteristics

ITEM	SYMBOL	CONDITION	MIN.	TYPE	MAX.	UNIT
Logic Voltage	V_{DD}-V_{SS}	-	4.5	5.0	5.5	V
Supply Volt.For LCD	V_{DD}-V_O	Ta=25℃	---	13.5	---	V
Input High Volt.	V_{IH}	-	V_{DD} -2.2	-	V_{DD}	V
Input Low Volt.	V_{IL}	-	0	-	0.8	V
Output High Volt.	V_{OH}	-	V_{DD} –0.3	-	V_{DD}	V
Output Low Volt.	V_{OL}	-	0	-	0.3	V
Supply Current	I_{DD}	-	---	18.0	---	mA

5. Backlight Information

Absolute Maximum ratings (Ta=25℃)

Item	Symbol	Conditions	Rating	Unit
Reverse voltage	Vr	-	10.0	V
Reverse Current	I_r	-	400	uA
Absolute maximum forward Current	Ifm		800	mA
Peak forward current	Ifp	1msec plus 10% Duty Cycle	2400	mA
Power dissipation	P_d		4000	mW
Operating Temperature Range	T_{oper}		-30~+70	℃
Storage Temperature Range	Tst		-40~+80	℃

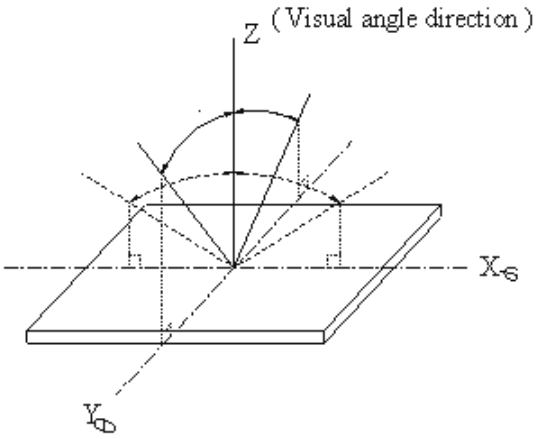
Electrical/Optical Characteristics (Ta=25^{0}C,If=110mA)

Color	Wavelength λp(nm)	Spectral line half width Δλ (nm)	Operating voltage(v)	Forward Current (mA)
White	---	---	3.0	110

6. Optical Characteristics

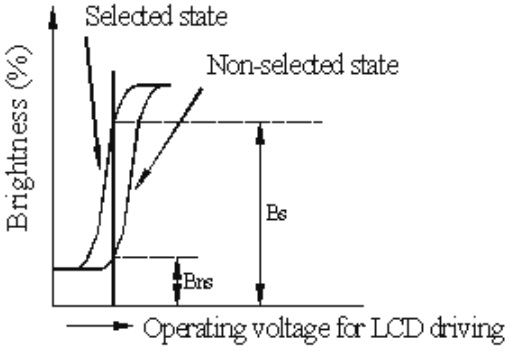
ITEM	SYMBOL	CONDITION	MIN	TYPE	MAX	UNIT
View Angle	(V) θ	CR≧2	10	–	120	deg.
	(H) ϕ	CR≧2	-45	–	45	deg.
Contrast Ratio	CR	–	–	5	–	–
Response Time	T rise	–	–	200	300	ms
	T fall	–	–	150	200	ms

■View Angles

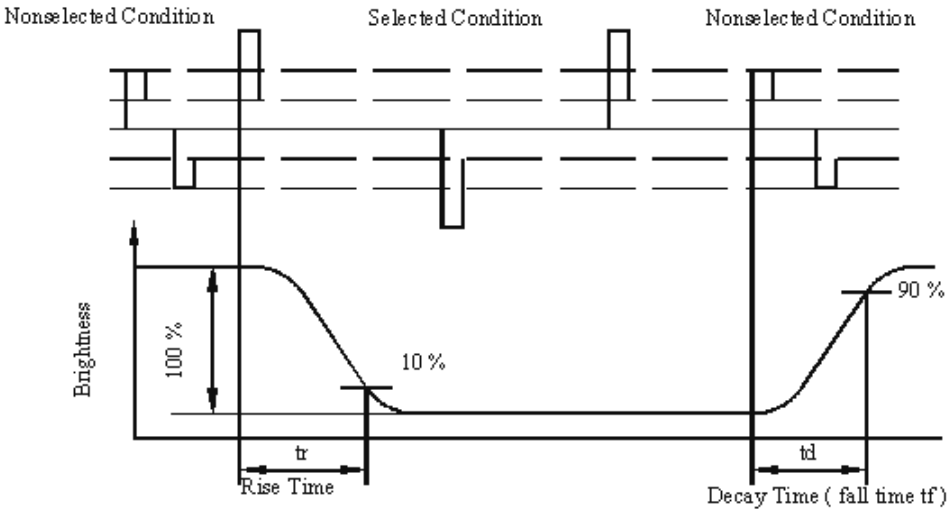


■Contrast Ratio

$$CR = \frac{\text{Brightness at selected state (BS)}}{\text{Brightness at non-selected state (Bns)}}$$



■Response time

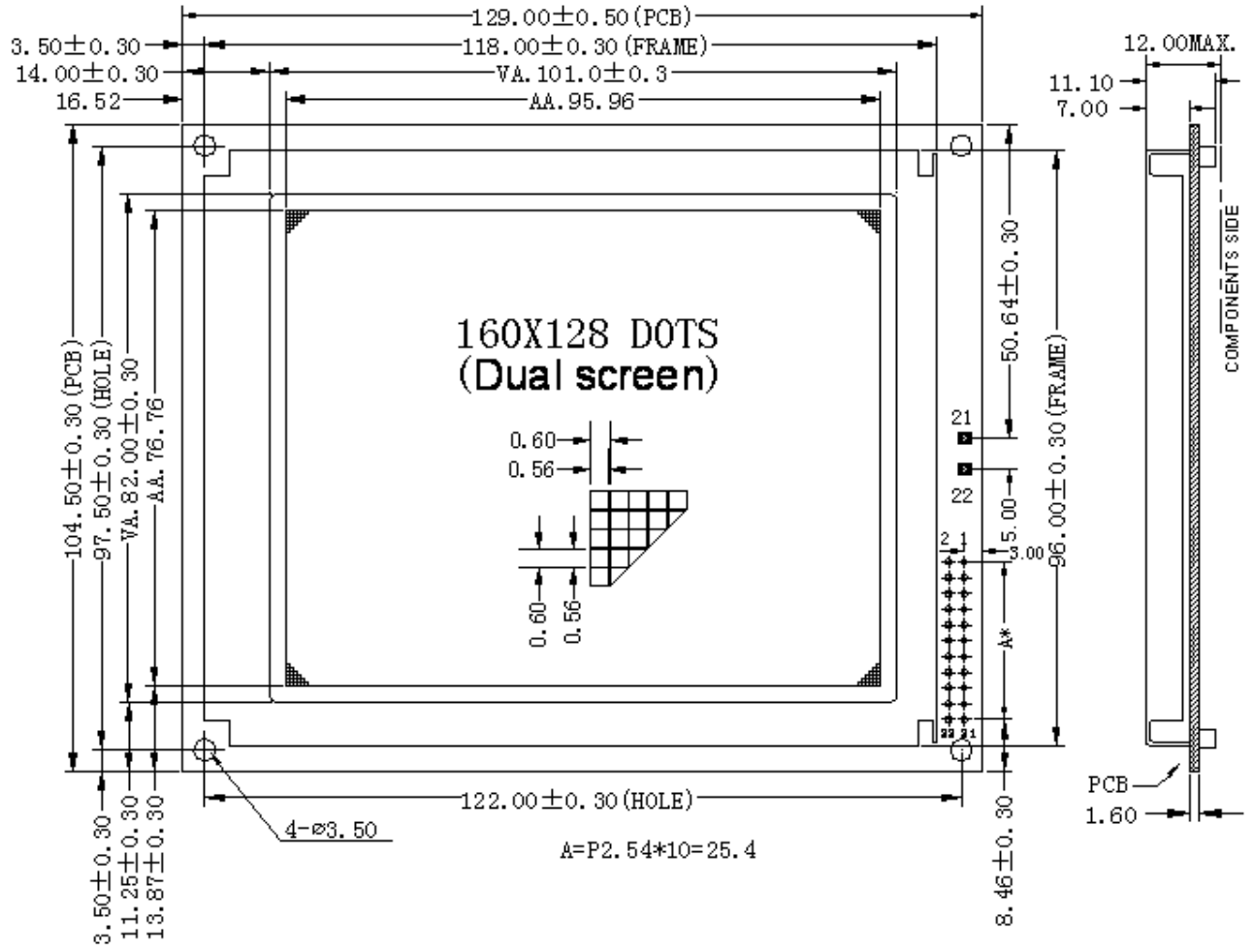


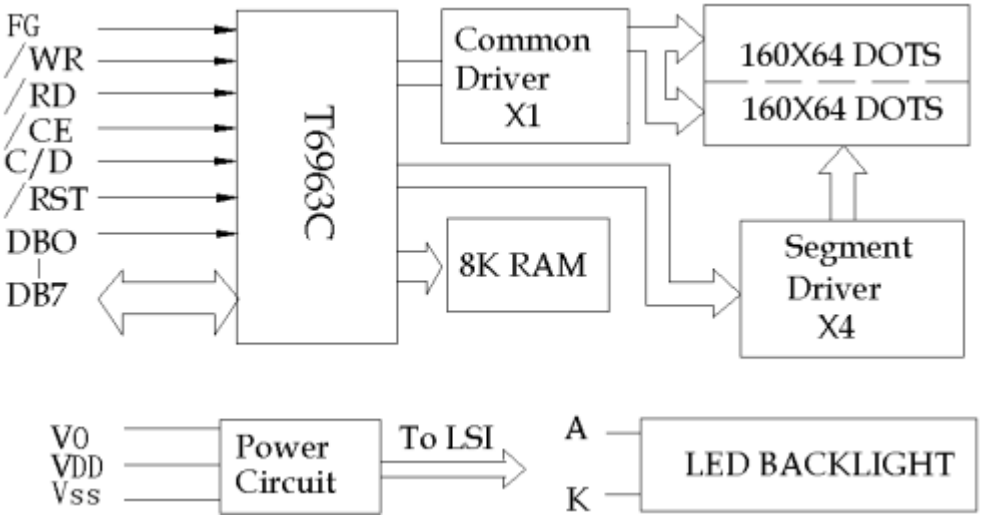
7.Interface Description

Pin No.	Symbol	Level	Description
1	FG	---	Frame ground
2	V_{SS}	0V	Ground
3	V_{DD}	5.0V	Power supply for Logic
4	V_O	(Variable)	Driving voltage for LCD
5	/WR	L	Write signal,active LOW
6	/RD	L	Read signal,active LOW
7	/CE	L	Chip enable,active LOW
8	C/D	H/L	H :Command L:Data
9	NC	---	No connectiion
10	/RST	L	LCM reset,active LOW
11~18	DB0~DB7	H/L	8-bit Data bus
19	FS	H/L	Font select H:6x8 L:8x8 (Default: “L”)
20	VEE	-15V	Negative voltage output (Default:No connection) (Option:built-in DC-DC convertor)
21	A(LED+)	+5V	Anode of LED Backlight Note1
22	K(LED-)	0V	Cathode of LED Backlight Note1

Note1:PIN21,PIN22 floating when Backlight power supply slectection jumper JA,JK shorted

8. Contour Drawing & Block Diagram

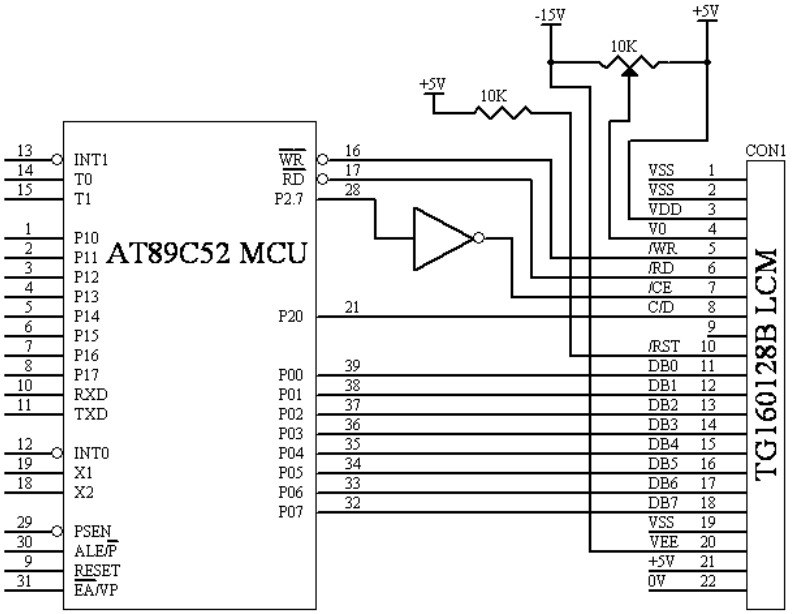




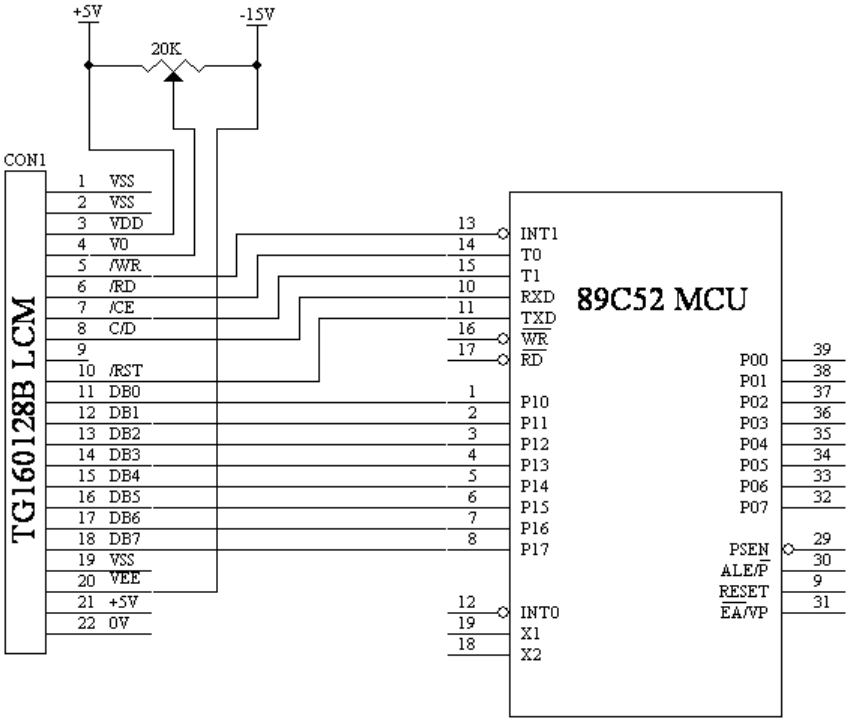
9. Application circuit

9.1 Interfaces with 8080-series MPU

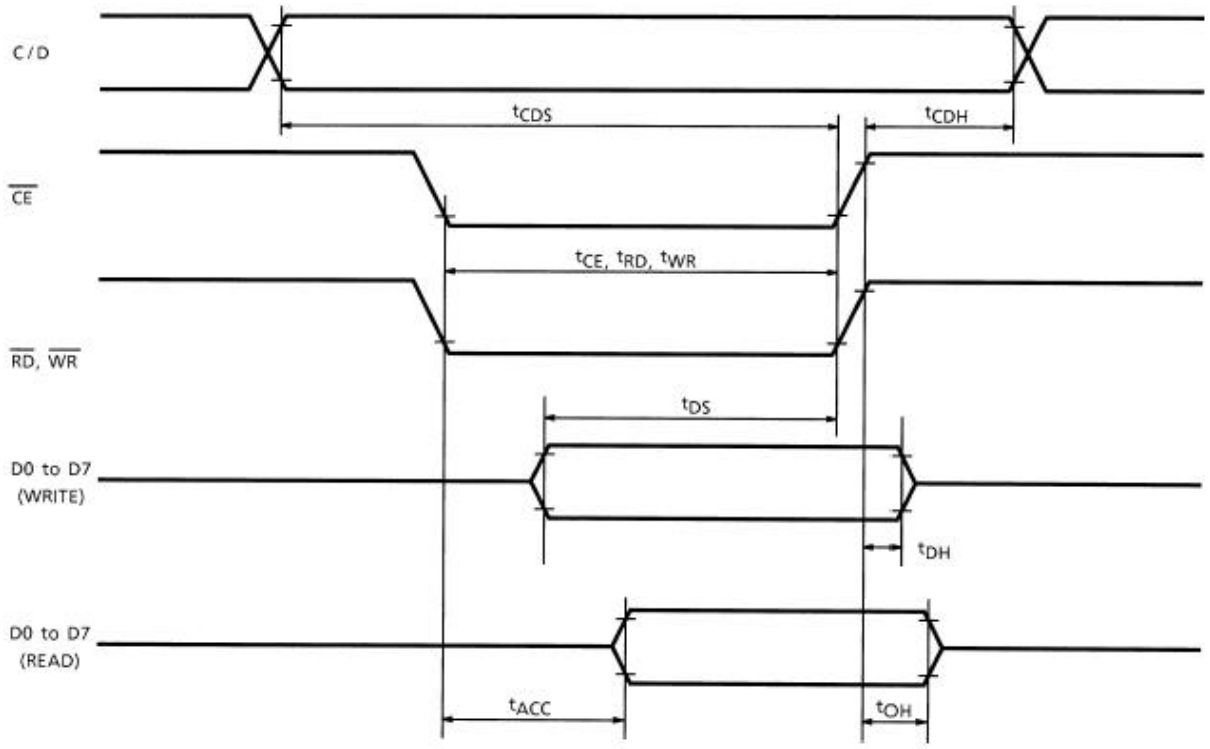
The LCM can be directly connected to an 8080-series MPU. The LCM can be used with an 8080-serial MPU as shown in the following application circuit.



9.2 Interfaces with 6800-series MPU



10. Timing Characteristics

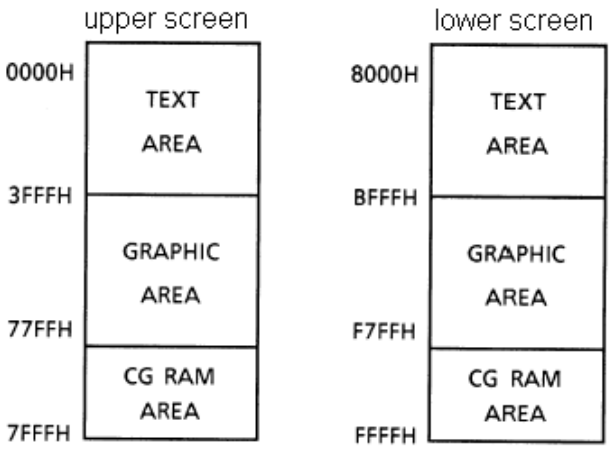


Test Conditions (Unless Otherwise Noted, VDD = 5.0 V ± 10%, VSS = 0 V, Ta = -20~75°C)

Item	Symbol	Test conditions	MIN.	MAX.	Unit
C / D Set-up Time	t_{CDS}	---	100	--	ns
C / D Hold Time	t_{CDH}	---	10	---	ns
/CE,/RD,/WR pulse width	t_{CE}, t_{RD}, t_{WR}	---	80	---	ns
Data Set-up Time	t_{DS}	---	80	---	ns
Data Hold Time	t_{DH}	---	40	---	ns
Access Time	t_{ACC}	---	---	150	ns
Output Hold Time	t_{OH}	---	10	50	ns

11. RAM Interface

This LCM use dual-scan mode, the address of upper LCD is allocated to 0000H to 7FFFH (32KB MAX.), the address of lower LCD is allocated to 8000H to FFFFH(32 KB MAX).Detail specification see page 8th in data sheet of T6963C.



12.Flowchart of communications with MPU

12.1 Status Read

A status check must be performed before data is read or written.

Status Check

Status of LCM can be read from data lines(Data bus).

RD = L, WR = H, CE = L, C/D = H, D0~D7 → Status word LCM.

The LCM Status word format is as follows.

MSB **LSB**

STA7	STA6	STA5	STA4	STA3	STA2	STA1	STA0
D7	D6	D5	D4	D3	D2	D1	D0
STA0	check capability of command execution				0: disable 1:enable		
STA1	check capability of data read/write				0: disable 1:enable		
STA2	check capability of auto mode data read				0: disable 1:enable		
STA3	check capability of auto mode data write				0: disable 1:enable		
STA4	not use						
STA5	check capability of controller operation				0: disable 1:enable		
STA6	error flag. using screen peek/copy command				0: no error		
STA7	check the condition blink				0: display off 1:normal display		

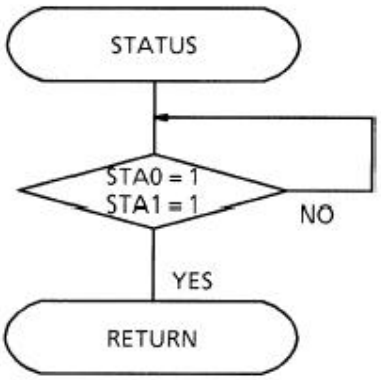
Note1: It is necessary to check STA0 and STA1 at the same time.
There is a possibility of error operation due to a hardware interrupt.

Note 2. For most modes STA0 / STA1 are used as a status check.

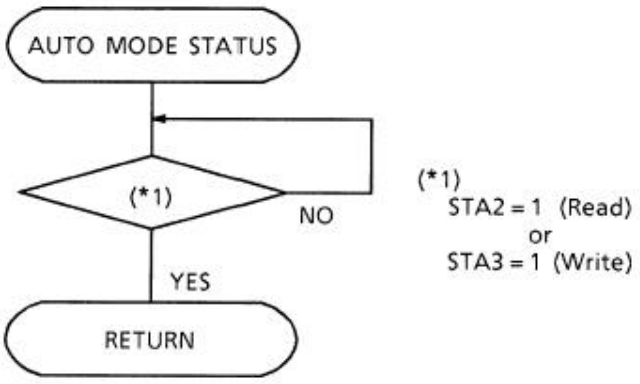
Note 3. STA2/STA3 are valid in Auto mode;STA0/STA1 are invalid.

Status checking flow

a)



b)



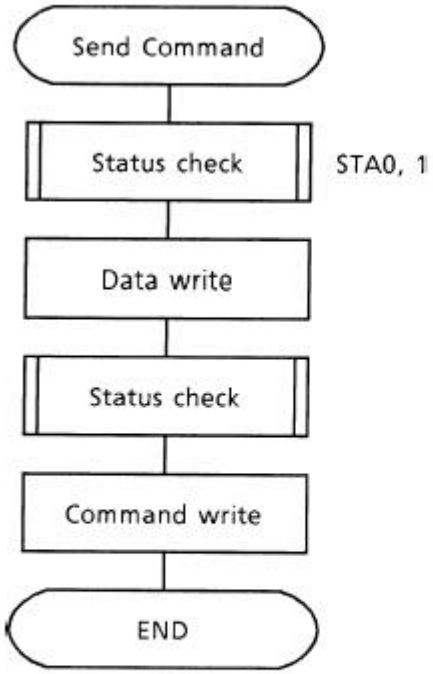
Note **4.** It is impossible to save status check in the case of command that is MSB 0. To have the delay time cannot be save status check. The interrupt of hardware is happened at the end of lines. If command of MSB0 is sent in this period, the command executing is waited. The state of waiting is not known without to check status. The sending next command or data is disregarded or rewrites data of waiting command.

12.2 Data Set

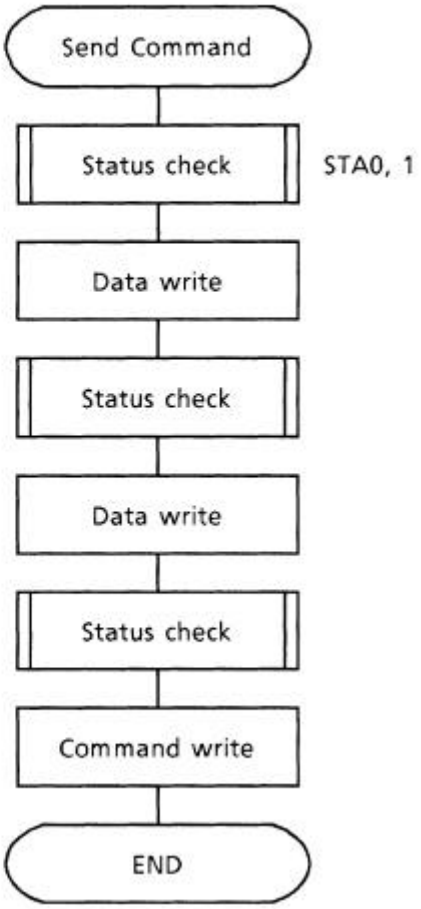
When using the LCM, first set the data(1 or 2 data), then set the command.

Procedure for sending a command

a) The case of 1 data



b) The case of 2 data



Note: When sending more than two data, the last datum (or last two data) is valid.

13. User instruction Definitions

13.1 Command Table

Command	Code(BIN)	Code(HEX)	D1	D2	Function	
Status Read	S0-S7		-	-	Read Status	
Reg Setting	00100001	21H	X Address	Y address	Set Cursor Pointer	
	00100010	22H	Data	00H	Set Offset Register	
	00100100	24H	Low address	High address	Set Address Pointer	
Set Control Word	01000000	40H	Low address	High address	Set Text Home Address	
	01000001	41H	Byte Number	00H	Set text area	
	01000010	42H	Low address	High address	Set Graphic Home Address	
	01000011	43H	ByteNumber	00H	Set Graphic Area	
Mode Set	1000*000	80H/88H	-	-	ORmode	*=0 Internal CG ROM
	1000*001	81H/89H	-	-	EXOR	
	1000*011	83H/8BH	-	-	AND	*=1 External CG RAM
	1000*100	84H/8CH	-		Text Attribute	
Display Mode	10010000	90H	-	-	Display off	
	1001xx10	92H	-	-	Cursor on, blink off	
	1001xx11	93H	-	-	Cursor on, blink on	
	100101xx	94H	-	-	Text on, graphic off	
	100110xx	98H	-	-	Text off, graphic on	
	100111xx	9CH	-	-	Text on, graphic on	
Cursor Pattern	10100D2-0	A0H~A7H	-	-	1~8Lines CURSOR Height	
Data Auto Read/Write	10110000	B0H	-	-	Set Data Auto Write	
	10110001	B1H	-	-	Set Data Auto Read	
	10110010	B2H	-	-	EXIT auto operation	
Data Read/Write	11000000	C0H	DATA	-	Data Write and Increment ADP	
	11000001	C1H	-	-	Data Read and Increment ADP	
	11000010	C2H	DATA	-	Data Write and Decrement ADP	
	11000011	C3H	-	-	Data Read and Decrement ADP	
	11000100	C4H	DATA	-	Data Write and Nonvariable ADP	
	11000101	C5H	-	-	Data Read and Nonvariable ADP	
Screen Peek	11100000	E0H	-	-	Screen peek	
Screen Copy	11101000	E8H	-	-	Screen Copy	
Bit Set/Reset	11110xxx	F0H→F7H	-	-	Bit Clear	
	11111xxx	F8H→FFH	-	-	Bit Set	

13.2 Description of command

13.2.1 Register setting

CODE	HEX	FUNCTION	D1	D2
00100001	21H	CURSOR POINTER SET	X address	Y address
00100010	22H	OFFSET REGISTER SET	DATA(DB0~DB4 is valid)	00H
00100100	24H	ADDRESS POINTER SET	LOW address	HIGH address

(1) CURSOR POINTER SET (D1-D2-21H)

The position of cursor is specified by X address, Y address, The cursor position is moved only by this command. The cursor pointer doesn't have the function of increment and decrement. The shift of cursor are set by this command.

X address, Y address are specified following

X address 00H~4FH (lower 7bits are valid)

Y address 00H~1FH (lower 5bits are valid)

1) 1 screen drive

X ADRS 00~4FH

Y ADRS 00H~0FH

2) 2 screen drive

X ADRS 00~4FH

YADRS 0H~0FH
upper screen

YADRS 10H~1FH
lower screen

(2)OFFSET REGISTER SET(D1-00-22H)

The offset register is used to determine external Character Generator RAM area.

The LCM assign External character generator, when character code set 80H to FFH in using internal character generator. Character code 00H to 80H assign External Character Generator, when External generator mode.

The senior five bits define the start address in external memory of the CG RAM area. The next eight bits represent the character code of the character. In internal CG ROM mode, character codes 00H to 7FH represent the predefined "internal" CG ROM characters, and codes 80H to FFH represent the user' s own "external" characters. In external CG RAM mode, all 256 codes from 00H to FFH can be used to represent the user' s own characters. The three least significant bits indicate one of the eight rows of eight dots that define the character' s shape.

MSB															LSB
AD15	AD14	AD13	AD12	AD11	AD10	AD9	AD8	AD7	AD6	AD5	AD4	AD3	AD2	AD1	AD0
Offset Register Data(5-bit)					Character Code(8-bit)								Line Scan(3-bit)		

The relationship between display RAM address and offset register

Offset register data	CG RAM hex. address (start to end)
00000	0000 to 07FFH
00001	0800 to 0FFFH
00010	1000 to 17FFH
11100	E000 to E7FFH
11101	E800 to EFFFH
11110	F000 to F7FFH
11111	F800 to FFFFH

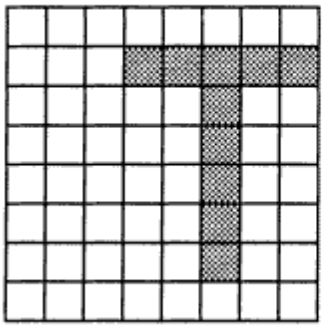
(Example 1)

Offset register 02H

Character code 80H

Character generator RAM start address:1400H

MSB															LSB
AD15	AD14	AD13	AD12	AD11	AD10	AD9	AD8	AD7	AD6	AD5	AD4	AD3	AD2	AD1	AD0
0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
Character generator RAM start address: 1400H															



(address)	(data)
1400H	00H
1401H	1FH
1402H	04H
1403H	04H
1404H	04H
1405H	04H
1406H	04H
1407H	00H

(3) Set Address Pointer(D1-D2-24H)

The address point set command is used to indicate the start address for writing to (or reading from) external RAM.

13.2.2 Control word set

CODE	HEX	FUNCTION	D1	D2
01000000	40H	TEXT HOME ADDRESS SET	Low address	High address
01000001	41H	TEXT AREA SET	Columns	00H
01000010	42H	GRAPHIC HOME ADDRESS SET	Low address	High address
01000011	43H	GRAPHIC AREA SET	Columns	00H

The home address and column size are defined by this command.

(1) Text home address set(D1-D2-40H)

The starting address of external display RAM for Text display is defined by this command. The text home address shows the left end and most upper position.

The relationship of external display RAM address and display position

TH		TH + CL
TH + TA		TH + TA + CL
(TH + TA) + TA		TH + 2TA + CL
(TH + 2TA) + TA		TH + 3TA + CL
~		~
TH + (n-1) TA		TH + (n-1) TA + CL

TH: Text Home address TA: Text Area number (columns)

CL: Columns are fixed by hardware, pin-programmable,this LCM can be set by jumper"J3" ,When J3 connected to "V" ,CL=32,and connected to "G", CL=40. Default: CL=40.

(example) Text home address = 0000H Text area = 0020H

CL=32 columns 4 lines

0000H	0001H		001EH	001FH
0020H	0021H		003EH	003FH
0040H	0041H		005EH	005FH
0060H	0061H		007EH	007FH

(2) Graphic home address set (D1-D2-42H)

The starting address of external display RAM for Graphic display is defined by this command.

The graphic home address shows the left end and most upper line.

The relationship of external display RAM address and display position

GH		GH+CL
GH+GA		CH+GA+CL
(GH+GA)+GA		GH+2GA+CL
(GH+2GA)+GA		GH+3GA+CL
~		~
GH+(n-1)GA		GH+(n-1)GA+CL

GH: Graphic Home address GA:Graphic area number (columns)

CL: Columns are fixed by hardware, pin-programmable,this LCM can be set by jumper"J3" ,When J3 connected to "V",CL=32,and connected to "G",CL=40.

Default: CL=40.

(example) **Graphic home address = 0000H** **Graphic area = 0020H**

CL=32 columns **2 lines**

0000H	0001H		001EH	001FH
0020H	0021H		003EH	003FH
0040H	0041H		005EH	005FH
0060H	0061H		007EH	007FH
0080H	0081H		009EH	009FH
00A0H	00A1H		00BEH	00BFH
00C0H	00C1H		00DEH	00DFH
00E0H	00E1H		00FEH	00FFH
0100H	0101H		011EH	011FH
0120H	0121H		013EH	013FH
0140H	0141H		015EH	015FH
0160H	0161H		017EH	017FH
01A0H	01A1H		01BEH	01BFH
01C0H	01C1H		01DEH	01DFH
01E0H	01E1H		01FEH	01FFH

(3)Text area set(D1-00-41H)

The columns of display are defined by the hardware setting. This command can be used to adjust columns of display.

(example) LCD size: 20 columns, 4 lines

Text home address = 0000H Text area = 0014H

CL=32 columns 4 lines

0000	0001	.....	0013	0014	.....	001F
0014	0015	.....	0027	0028	.....	0033
0028	0029	.....	003B	003C	.....	0047
003C	003D	.....	004F	0050	.....	005B

→ LCD ←

(4) Graphic area set (D1-00-43H)

The columns of display are defined by the hardware setting. This command can be used to adjust columns of graphic display.

(example)

LCD size: 20 columns, 2 lines

Graphic home address= 0000H Graphic area = 0014H

CL=32 columns 2 lines

0000	0001	.....	0013	0014	.....	001F
0014	0015	.....	0027	0028	.....	0033
0028	0029	.....	003B	003C	.....	0047
003C	003D	.....	004F	0050	.....	005B
0050	0051	.....	0063	0064	.....	006F
0064	0065	.....	0077	0078	.....	0083
0078	0079	.....	008B	008C	.....	0097
008C	008D	.....	009F	00A0	.....	00AB
00A0	00A1	.....	00B3	00B4	.....	00BF
00B4	00B5	.....	00C7	00C8	.....	00D3
00C8	00C9	.....	00DB	00DC	.....	00E7
00DC	00DD	.....	00EF	00F0	.....	00FD
00F0	00F1	.....	0103	0104	.....	011F
0104	0105	.....	0127	0128	.....	0123
0128	0129	.....	013B	012C	.....	0137
013C	013D	.....	014F	0140	.....	014B

→ **LCD** ←

The address in graphic area can be continuous and RAM area can be used without ineffective area, if graphic area is defined the same number as the actual column number of LCD display.

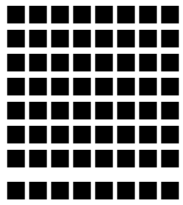
13.2.3 Mode set

CODE	FUNCTION	Operand
1000X000	"OR" mode	
1000X001	"EXOR" mode	
1000X011	"AND" mode	
1000X100	"TEXT ATTRIBUTE" mode	
10000XXX	internal character generator mode	
10001XXX	external character generator mode	

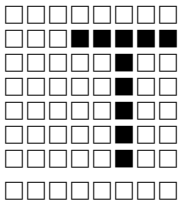
X:invalid

The display mode is defined by this command. The display mode doesn't change until this command is sent. Logically "OR", "EXOR", "AND" of text and graphic display can be displayed. When internal character generator mode is selected, character code 00H~7FH are selected from built-in character generator RM. The character code 80H~FFH are automatically selected from external character generator RAM.

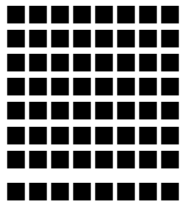
(example)



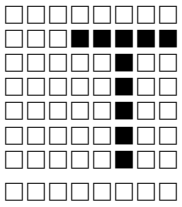
Graphic



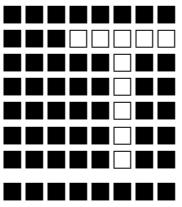
Text



" OR"



" AND"



" EXOR"

Note: Only text display is attributed, because attribute data is located in graphic RAM area.

Attribute function

"Reverse display", "Character blink" and "Inhibit" are called "Attribute". The attribute data is written into the graphic area defined by "Control word set" command. Only text display is possible in Attribute Function mode; graphic display is automatically disabled. However, the Display Mode command must be used to turn both Text and Graphic on in order for the Attribute function to be available.

The attribute data of the 1st character in text area is written at the 1st 1 byte in graphic area, and attribute data of n-th character is written at the n-th 1 byte in graphic area.

Attribute function is defined as follows:

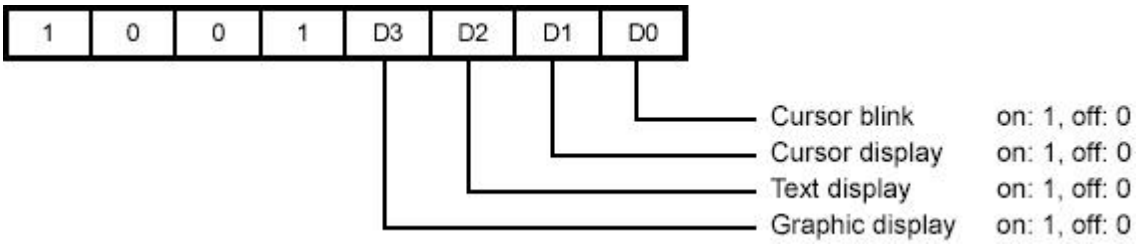
Attribute RAM 1 Byte	X	X	X	X	d3	d2	d1	d0

d3	d2	d1	d0	FUNCTION
0	0	0	0	normal display
0	1	0	1	reverse display
0	0	1	1	inhibit display
1	0	0	0	blink of normal display
1	1	0	1	blink of reverse display
1	0	1	1	blink of inhibit display

X: don't care

13.2.4 Display mode

CODE	FUNCTION	Operand
10010000	display off	
1001XX10	cursor on, blink off	
1001XX11	cursor on, blink on	
100101XX	text on, graphic off	
100110XX	text off, graphic on	
100111XX	text on, graphic on	



Note: It is necessary to turn on “text” display“ and ”graphic display“ in following case.

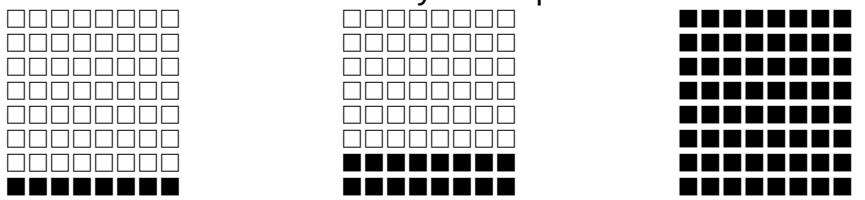
1) Combination of text/graphic display
2) Attribute function

13.2.5 Cursor pattern select

CODE FUNCTION

A0H~A7H 1~8 line cursor

When cursor display is ON, this command selects the cursor pattern from 1 line to 8 lines. The cursor address is defined by cursor pointer set command.



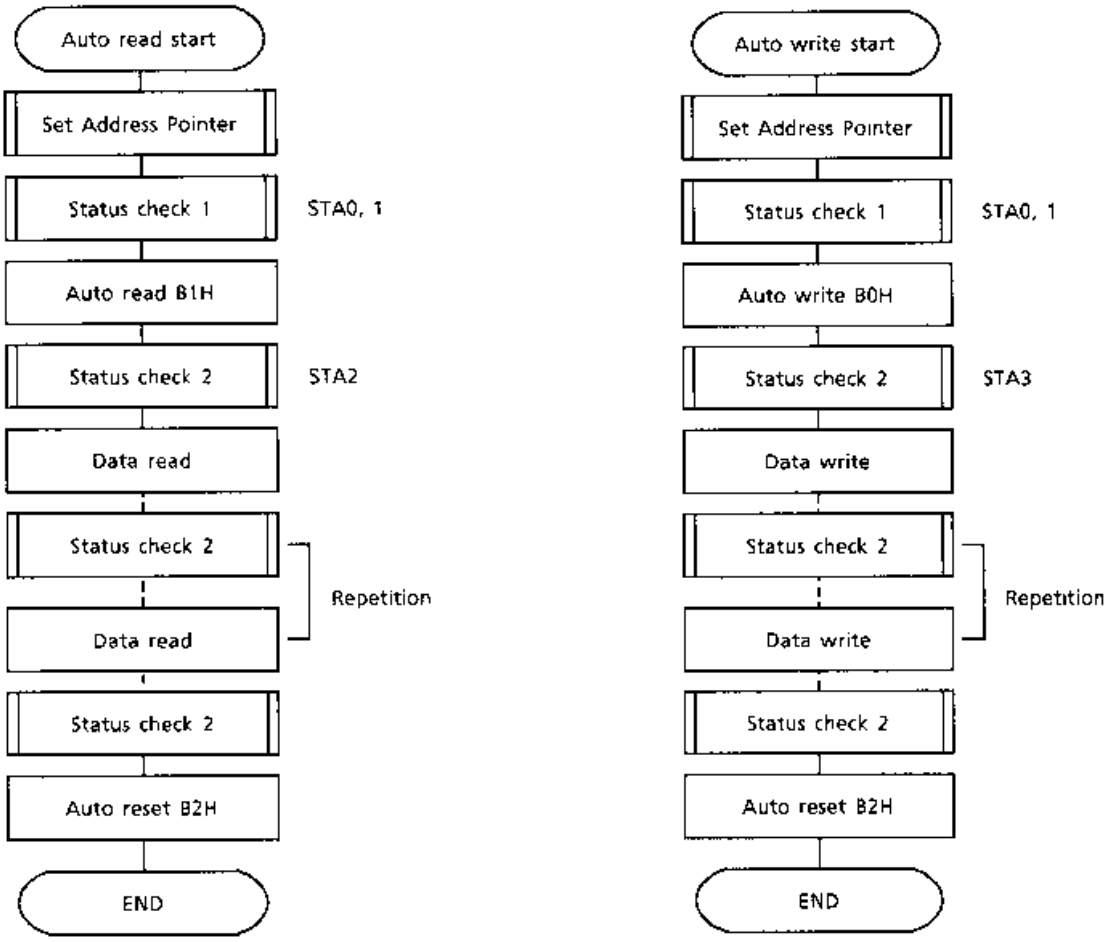
1 line cursor **2 lines cursor** **8 lines cursor**

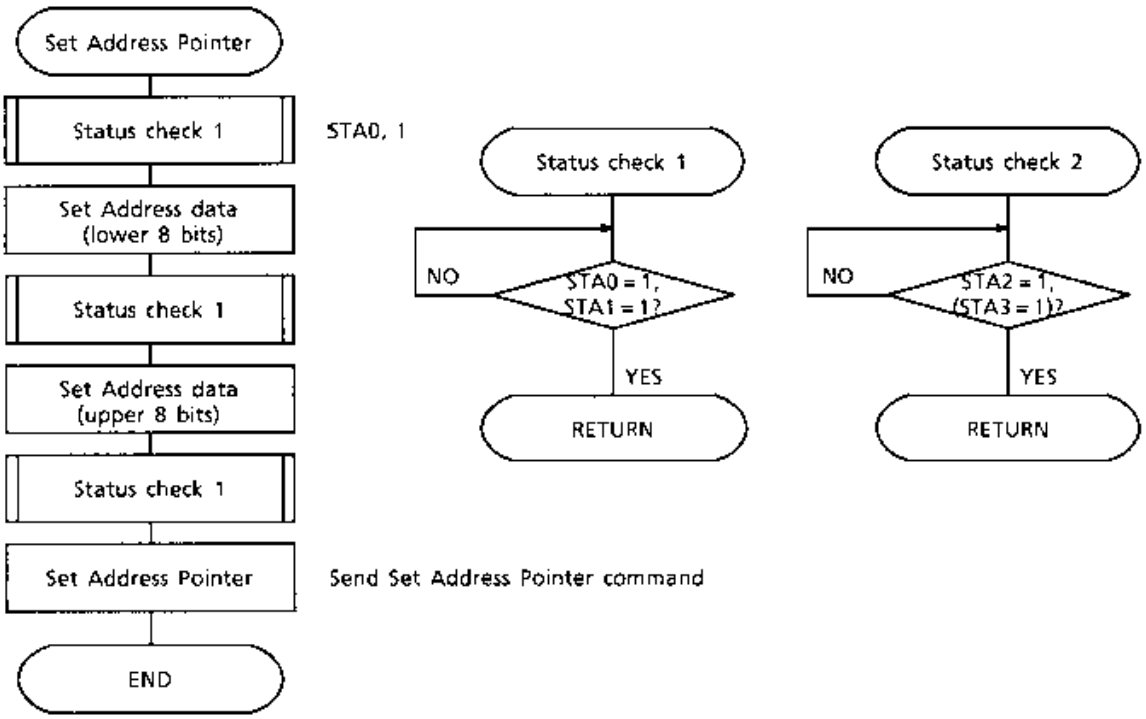
13.2.6 Data auto read/write

CODE(BIN)	CODE(HEX)	FUNCTION	Operand
10110000	B0H	Data auto write set	---
10110001	B1H	Data auto read set	---
10110010	B2H	EXIT auto operation	---

This command is convenient to send full screen data from external display RAM. After setting auto mode, “data write (or read)” command is not necessary between each data. “Data auto write (or read)” command should follow the “Address pointer set” and address pointer is automatically increment by +1 after each data “auto reset” is necessary to return normal operation because all data is regarded “display data” and no command can be accepted in the auto mode.

Note: A Status check for auto mode (STA2, STA3 should be checked between each data. Auto reset should be performed after checking STA3=1 (STA2=1).Refer following flow chart.





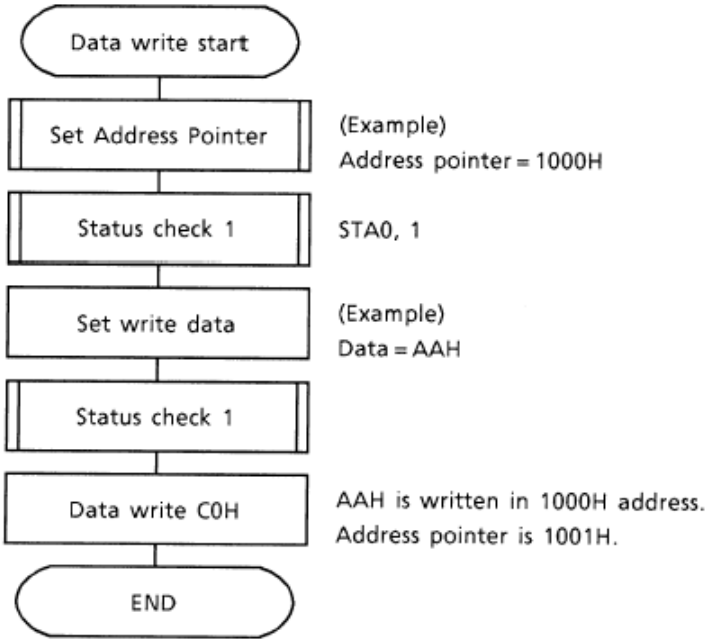
13.2.7 Data read write

CODE(BIN)	CODE(HEX)	FUNCTION	Operand
11000000	C0H	Data Write and Increment ADP	data
11000001	C1H	Data Read and Increment ADP	-
11000010	C2H	Data Write and Decrement ADP	data
11000011	C3H	Data Read and Decrement ADP	-
11000100	C4H	Data Write and Nonvariable ADP	data
11000101	C5H	Data Read and Nonvariable ADP	-

This command is used for data write from MPU to external display RAM to MPU. Data write/read should be executed after setting address by address pointer can be automatically increment or decrement by setting this command.

Note: This command is necessary for each 1 byte data.

Refer following flow chart.



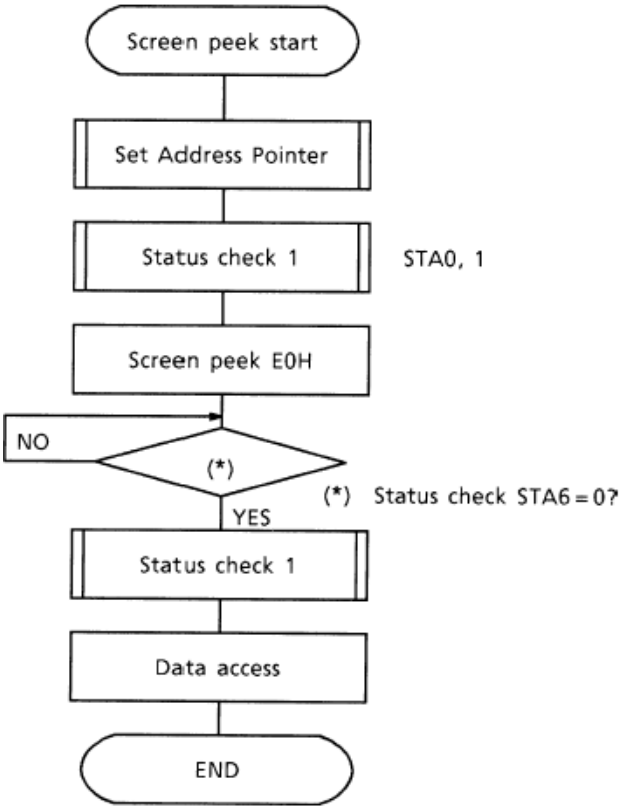
13.2.8 Screen peek

CODE(BIN)	CODE(HEX)	FUNCTION	Operand
11100000	E0H	screen peek	---

This command is used to transfer displayed 1 byte data to data stack, and this 1 byte data can be read from MPU by data access.

The logical combination data of text and graphic display on LCD screen can be read by this command. The status (STA6) should be checked just after “screen peek” command. If the address command is not in graphic area, this command ignored and status flag (STA6) is set.

Refer following flow chart.



Note: This command is available when hardware column number and software column number are the same.
Hardware column number is related to jumper “J3” setting. Default: CL=40.
Software column number is related to Set Text Area and Set Graphic Area command.

13.2.9 Screen copy

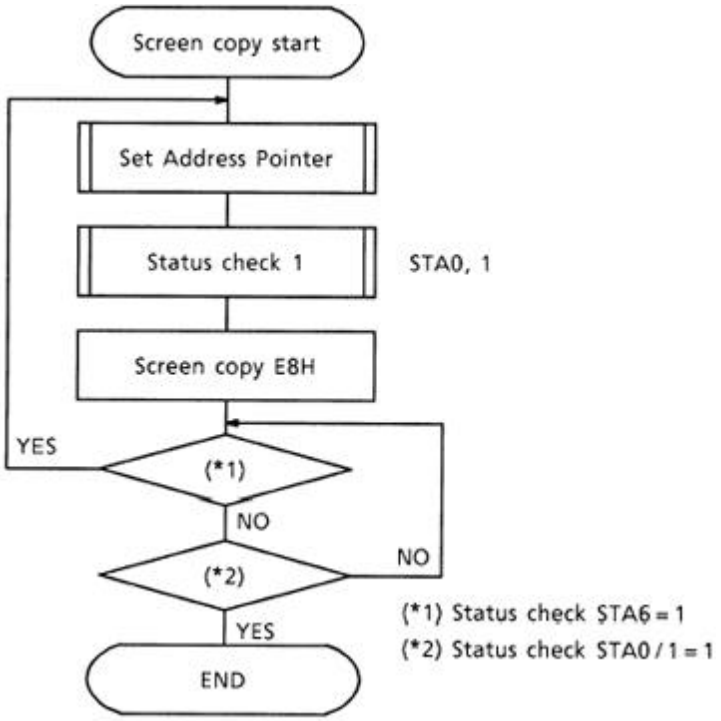
CODE(BIN)	CODE(HEX)	FUNCTION	Operand
11101000	**E8H**	**screen copy**	**---**

This command is used to copy displayed 1 line data to graphic area. The start point of 1 line data in the screen is determined by the address pointer.

Note:a) When the attribute of text is used this command cannot be used. (because attribute data is in the graphic area.)

b) In case of 2 screen drive, this command cannot be used. (because T6963c cannot separate upper screen data and lower screen data.)

Refer following flow chart.



Note: This command is available when hardware column number and software column number are the same.

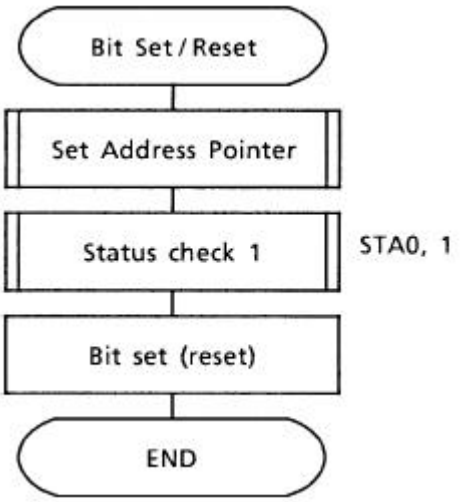
Hardware column number is related to jumper “J3” setting. Default: CL=40.

Software column number is related to Set Text Area and Set Graphic Area command.

13.2.10 Bit set/reset

FUNCTION	CODE(BIN)	CODE(HEX)	Bit0	Bit1	Bit2	Bit3	Bit4	Bit5	Bit6	Bit7
Bit reset	11110XXX	F0H~F7H	F0H	F1H	F2H	F3H	F4H	F5H	F6H	F7H
Bit set	11111XXX	F8H~FFH	F8H	F9H	FAH	FBH	FCH	FDH	FEH	FFH

This command is used to set or reset a bit of 1 byte is specified by address pointer. Plural bits in the 1 byte data cannot be set/reset at a time.



14. Initializing flow chart

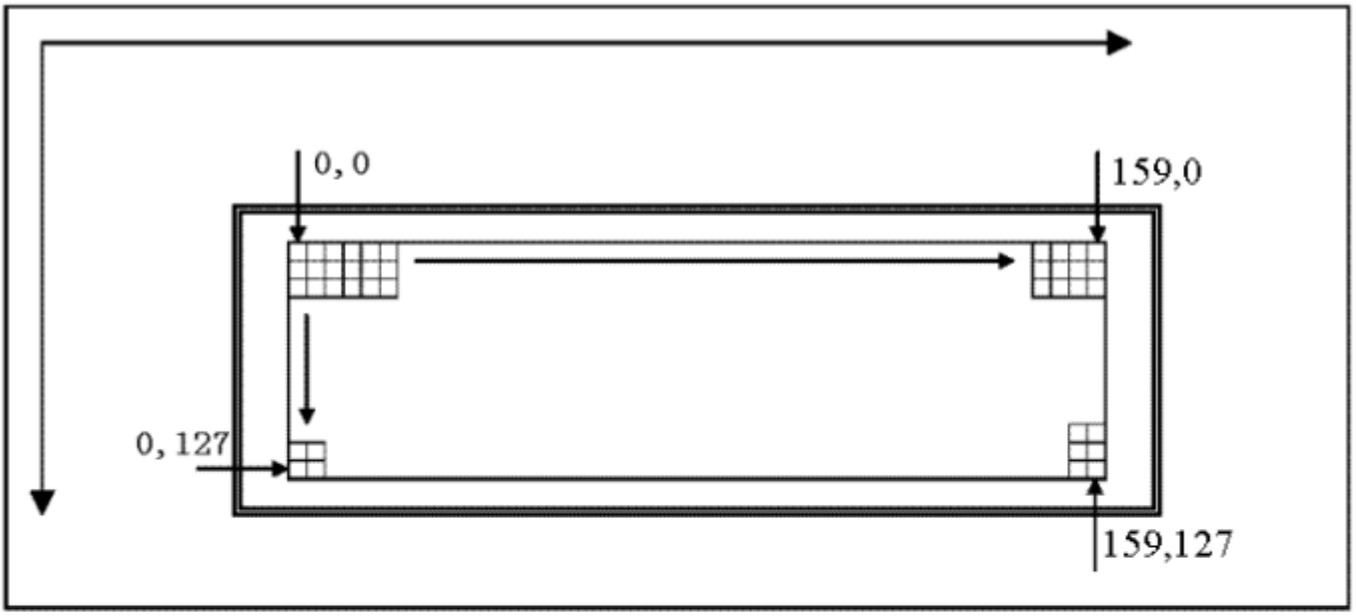
Initialize of LCM is required for “Mode set”, “Control word set” after power on. Following is the one example of initialize procedure of 160X128 dots display (In case of 8x8 dots/font: FS=L).

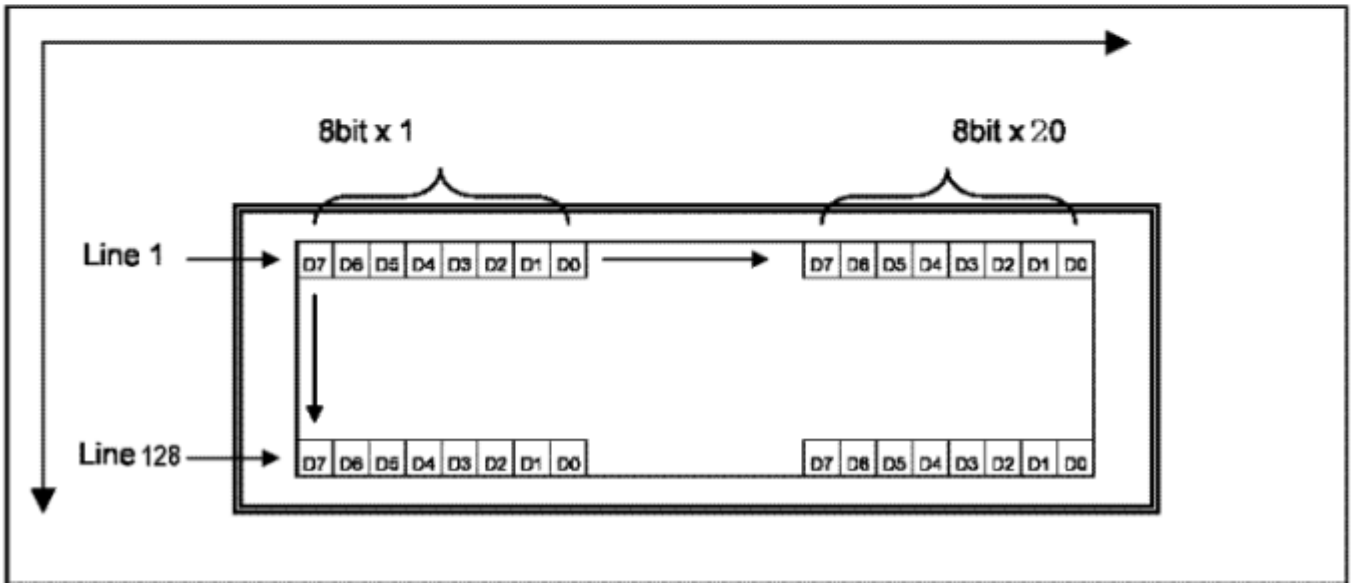
Command	C/D	D7 ----------D0	Note
Power on	Power on		
Hard reset (use reset terminal)	RESET=“ L” (1msec minimum after VDD>4.75V)		
Mode set	1	1 0 0 0 0 0 0 0	“ OR” mode
Control word set			
Graphic home position set	0	0 0 0 0 0 0 0 0	graphic home address
(Graphic home position 000H)	0	0 0 0 0 0 0 0 0	
	1	0 1 0 0 0 0 1 0	command
Number of graphic area set	0	0 0 0 1 0 1 0 0	number of area
(Graphic 20X8 dots)	0	0 0 0 0 0 0 0 0	
	1	0 1 0 0 0 0 1 1	command
Text home position set	0	0 0 0 0 0 0 0 0	text home address
(Text home position 1000H)	0	0 0 0 1 0 0 0 0	
	1	0 1 0 0 0 0 0 0	command
Number of text area set	0	0 0 0 1 0 1 0 0	number of area
(text 20 column)	0	0 0 0 0 0 0 0 0	
	1	0 1 0 0 0 0 0 1	command
Initialize end , Data Write			
Address pointer set	0	0 0 0 0 0 0 0 0	graphic home address
(address pointer 0000H)	0	0 0 0 0 0 0 0 0	
	1	0 0 1 0 0 1 0 0	command
Data Write (graphic)	0	0 1 0 1 0 1 0 1	Data
	1	1 1 1 0 0 0 0 0	command
	0	1 0 1 0 1 0 1 0	Data
	1	1 1 1 0 0 0 0 0	command
	x	x x x x x x x x	
Address pointer set	0	0 0 0 0 0 0 0 0	text home address
(address pointer 1000H)	0	0 0 0 1 0 0 0 0	
	1	0 0 1 0 0 1 0 0	command
Data write (text)	0	0 0 1 1 0 1 0 0	Data
	1	1 1 0 0 0 0 0 0	command
	0	0 0 1 0 1 1 1 1	Data
	1	1 1 0 0 0 0 0 0	command
	x	x x x x x x x x	
Display Mode Set (text/graphic on)	1	1 0 0 1 1 1 0 0	

Note:

1. “status check” should be inserted between all command and data.
2. Display mode set register is cleared (no display mode) by the hard reset , and no display is appeared on LCD panel. And just after “Display Mode set 9CH”, written data is display on the LCD.

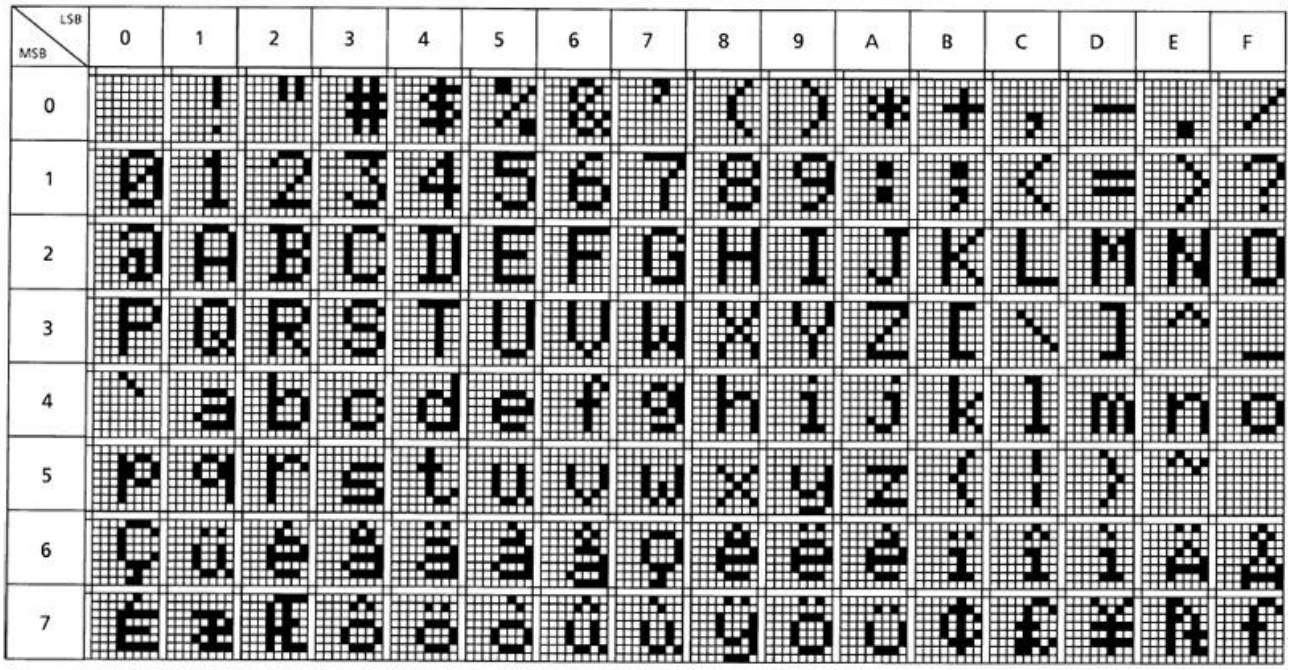
15. LCM RAM map





16. Standard Character pattern

The relation between character codes and character pattern (CG ROM TYPE 0101)



17. Revision records

Version	Ref.pages	Revision Items	Date
A00	All pages	New release	2006.08.02